SECTION 1

REMARKS

Applicant herein responds to Examiner's numbered actions as follows:

1. The current application is being rejected for non-statutory double patenting as it relates to copending applications 08/631,821 and 08/642,661. Although not mentioned by the examiner copending applications 08/647,459 08/643,213, 08/642,596, 08/628,288, and 08/642,497 as listed in Table I and Table II provided herein have also been submitted by applicant. These applicants for related concepts should also be considered by the examiner regarding possible non-statutory double patenting.

In the analysis that follows, applicant believes he has provided adequate justification for separate patents. However, all of the copending applications were entered at substantially the same time. Applicant expected that if allowed, the issue dates of the eight patents would be at substantially the same time. Therefore, the problem of double patenting is a moot point. **Applicant will issue a terminal disclaimer in compliance with 37 CFR 1.321(b) and (c) for each of the patent applications listed in Tables I and II provided on the next two pages.** This will avoid the issue of double patenting. The terminal disclaimer will disclaim the terminal part of each patent beyond the expiration date of the first patent issued.

- TABLE I PLANER DESIGN -

APPLICATION NO.	DEFINING CHARACTERISTICS
08/628,288 Planer Light Concentrating Lighting Device Filing date 4/04/96 Examiner: Matthew Spark (703-306-2766) PTO action dated 4/28/96 answered on 8/07/97	** Reflected light converges about reference plane, diverges about axis + reflector comprises a parallel movement of a parabolic line about a reference plane + ** reflected light is refracted to bring it towards parallelism with reference plane
08/642,596 Converging Reflector **Planer** Light Concentrating Lighting Device Filing date 5/03/96 Examiner: Matthew Spark (703-306-2766) PTO action dated 4/28/97 answered on 10/28/97	** Reflected light converges about reference plane, diverges about axis + Reflector comprises a parallel movement of a elliptical line about a reference plane + elliptical line axis parallel with reference plane + ** reflected light is refracted to bring it towards parallelism with reference plane
08/647,459 Angled Converging Reflector Planer Light Concentrating Lighting Device Filing date 5/03/96 Examiner: Matthew Spark (703-306-2766 Art Unit - 3406 PTO action dated 8/21/97 to be answered by 2/21/98	** Reflected light converges about reference plane, diverges about axis + Reflector comprises a parallel movement of a elliptical line about a reference plane + elliptical line axis intersecting reference plane + ** Reflected light is refracted to bring it towards parallelism with reference plane
08/643,213 Bent Refractor **Planer** Light Concentrating Lighting Device Filing date 5/03/96 Examiner: Matthew Spark (703-306-2766) PTO action dated 8/21/97 to be answered by 2/21/98	** Reflected light converges about reference plane, diverges about axis + Refractor comprises a parallel movement of a curved line about reference plane + ** reflected light is refracted to bring it towards parallelism with reference plane

** Feature common to all copending applications of planer design

It is noteworthy to realize that **application 08/643,213** represents the broadest application of the concept of increasing efficiency by reflecting the light to converge about the reference plane. It achieves this by using a reflector developed about the reference plane. This is easily achieved by a parallel movement of a line about the reference plane. **Application 08/628,288** reads on 08/643,213 but adds the requirement that the reflector be developed using a parabolic line. **Application 08/642,596** reads on 08/643,213 but adds the requirement that the reflector be developed by a movement of an elliptical line about the reference plane with the elliptical line axis parallel to the reference plane. **Application 08/647,459** reads on 08/643,213 but adds the requirement that the reflector be developed by a movement of an elliptical line about the reference plane with the elliptical line axis intersecting the reference plane.

- TABLE II AXIAL DESIGN -

APPLICATION NO.	**DEFINING CHARACTERISTICS**
08/631,821 Axial Light Concentrating Lighting Device Filing date 4/10/96 Examiner: Haynes M. (703-308-5460) PTO office action dated 06/02/97 to be answered BY 12/02/97	* Reflected light converges about axis + Reflector is formed of a rotary movement of a parabolic line about said reference axis + * Reflected light is refracted to bring it towards parallelism with axis
08/642,661 Converging Reflector Axial Light Concentrating Lighting Device Filing date 5/13/96 Examiner: Williams J. Unit 2215 (703-306-4469) PTO office action dated 5/27/97 to be answered BY 11/27/97	* Reflected light converges about axis + Reflector is formed of a rotary movement of a elliptical line about said reference axis + elliptical line axis coincident with reference axis + * reflected light is refracted to bring it towards parallelism with axis
08/647,461 Angled Converging Reflector Axial Light Concentrating Lighting Device Filing date 5/03/96 Examiner: Mark Haynes (703-308-5460) PTO office action dated 06/02/97 to be answered BY 12/02/97	* Reflected light converges about an axis + Reflector is formed of a rotary movement of a elliptical line about said reference axis + elliptical line axis intersecting the reference axis + * Reflected light is refracted to bring it towards parallelism with axis
08/642,497 Bent Refractor Axial Light Concentrating Lighting Device Filing date 5/03/96 Examiner: Matthew Spark (703-306-2766 PTO office action dated 4/18/97 ans. by 8/07/97	* Reflected light converges about axis + Reflector is developed by rotary movement of a curved line about reference axis + * Reflected light is refracted to bring it towards parallelism with axis

* Feature common to all copending applications of axial designs

It is noteworthy to realize that application 08/642,497 represents the broadest application of the concept of increasing the efficiency by reflecting the light to converge about the reference axis. Application 08/631,821 reads on application 08/642,497 but it adds the requirement that the reflector also be developed from a parabolic line. Application 08/642,661 reads on application 08/642,497 but it adds the requirement that the reflector be developed using an elliptical line with its axis coincident with the reference axis. Application 08/647,461 reads on 08/642,497 but it adds the requirement that the reflector is developed using an elliptical line with its axis intersecting the reference plane.

Analysis - The following analysis regarding double patenting is provided. However, due to the offered disclaimer it may not be required.

All copending applications disclose concepts which are more complex and more expensive than the basic and universally used LED light source 20S as found in FIG. 8 of the current application. If these **larger, more complex** and **more expensive** designs do not provide substantial increases in intensity over the basic compact and inexpensive light source 20S they are not commercially usable. Efficient control and management of the light energy is the **crucial** element of all of the copending applications as well as all referenced prior art including Bitner and Sakai. Each of the applications represent different methods of management of the light energy. Thus, there are large differences amongst the copending applications regarding light management which is the most **crucial** feature of these devices. In this critical area the applications can be considered separate designs.

Further, each of the copending applications can become the superior design for a particular use depending upon the needs of that use. For instance, if one use placed the lighting device in a high temperature environment, the designer would be forced to employ a resin that performs well in high temperature. That high temperature resin could - due to the limited choice of resins-unfortunately also have the negative characteristic of low light transmissivity. This would make a larger or thicker design especially problematic as its transmission loss profile would become catastrophic in that most of the light would be lost as it passed through the thick device. Other uses may permit the designer to select a resin with very high transmissivity yet - due to needs such as toughness etc. - force the designer to select a resin with high viscosity, large shrinkage or poor surface finish making it more difficult to cast the precise optical shape required. This would make the transmission loss profile less of a problem but increase the importance of the loss

profile due to optical surface precision. Thus, as the users needs change each of the copending applications can become the superior choice depending upon a number of factors including: size of the LED element, manufacturing technique, cost of resin, environmental temperature, size of the lighting device, toughness required, etc.

Furthermore, each of the copending applications is approximately 22 pages long. While it is true that some duplicate paragraphs could be removed if all of the designs were incorporated into a single application it is also true that the single large application would become long and complex as it would be required to describe three different light management concepts.

The different concepts for the four planer copending applications on Table I are as described below. A similar analysis holds for the four axial designs found in Table II.

Bent Refractor Planer Light Concentrating Lighting Device 08/643,213 requires the reflector to bend the light so that it converges about the reference plane. The light remains divergent about the reference axis. The light intersects a bent refractor where it is refracted to bring it towards parallelism with the reference plane. This design does not require the reflected light to be parallel or converge upon the reference axis. In this application the refractive surface is bent. This creates a refractive loss which changes for each impinging light ray or group of light rays depending upon that light rays angle of incidence relative to the normal at the point of intersection on the refractive surface.

Planer Light Concentrating Lighting Device 08/628,288 requires the reflector to reflect the side light to converge about the reference plane and to intersect the refractor where it is refracted to bring it towards parallelism with the reference plane similar to application 08/643,213. However, in application 08/628,288 the reflector must additionally comprise a parabolic contour which makes the reflected light in each plane parallel. In FIG. 5 of the drawings for this application it can be seen

that intersection line 14L of plane P2 and refractor surface 14 is a straight line. This is a result of the parabolic reflector and it means that all the reflected light impinging upon the refractive surface intersects it at the same constant angle relative to the surface normal at the point of intersection. This design therefore creates a constant refractive loss profile regardless of the initial angle of divergence of the side light relative to reference plane P1.

Angled Converging Reflector Planer Light Concentrating Lighting Device 08/647,459 requires a elliptical reflector to bend the light so that it converges about the reference plane similar to application 08/643,213. This light also remains divergent about the reference axis. In this design the reflector is an elliptical surface with its axis intersecting the reference plane. Because of the orientation of the elliptical axis the light will additionally converge to focus at points a distance from the reference plane. This small change in the description represents a further change in the light management and loss profiles.

Converging Reflector Planer Light Concentrating Lighting Device 08/642,596 requires the reflector to bend the light so that it converges about the reference plane **similar to application 08/643,213. This light also remains divergent about the reference axis.** This application employs a reflective surface which is developed using a parallel movement of an elliptical line. The elliptical surface is developed about an axis coincident with the reference plane. Therefore, the light converges upon the reference plane. The light is additionally focused upon points on the reference plane. Due to the orientation of the axis of the elliptical reflector, the corresponding refractive surface has a different orientation relative to the reference plane then the refractive surface of application 08/647,459. Thus the corresponding refractive surface for this design has a refractive loss profile different from any of the copending applications including 08/647,459. Also the overall loss profile

including transmission, reflective, refractive and precision loss profiles is different then all the copending designs.

The four additional copending applications which relate to axial designs are also believed by applicant to be separate inventions. These are application numbers 08/631,821, 08/642,661, 08/642,497 and 08/647,461. These four additional applications all represent designs with optics developed about an axis of revolution with the light bent to become concentrated about that axis. A summary of these applications is provided in Table II. The current application is an axial design and belongs in Table II. It is different from the other designs on Table II. It is noteworthy to realize that designs which bend the light towards a reference axis are more restrictive and less efficient than designs which permits the light to remain divergent about an axis while only bending the light to become convergent towards a reference plane. Thus Table I represents designs substantially different from Table II even though the profiles of the optics are identical in the single vertical reference plane shown in Drawing I.

Applicant's eight copending applications are similar in that they all have refraction after reflection. However, they all have different refractive systems. Refraction creates losses which are dependent upon the degree of refraction, i.e. more refraction (especially above 20 degrees) increases the losses due to internal reflection until total internal reflection makes the refractive losses 100 percent (critical angle). Each of the copending applications also have different reflection systems and thus each has its own reflective loss profile. The reflective loss profiles are derived from equations similar to those used to determine the refractive loss profiles whenever the reflective surface is not plated. Usually due to cost, production problems and efficiency related to second surface plating, the reflective surface is not plated. Additionally, each of the copending applications disclose different shapes and thicknesses of resin which establish different light transmission loss profiles.

Finally, each design has a different shape and resin mass establishing different optical surface precision loss profiles. The quantity of resin will also effect the weight of the device and the cost to manufacture. The cumulative effect of the described loss profiles establishes the light management and overall efficiency of each design. Thus the "small" differences between the disclosures and wording of the claims of each copending application can represent substantive differences in the crucial issue of light management and performance.

Drawing 1 enclosed on the following page may be helpful in understanding applicants response. It shows how a single light ray would be directed by each of the copending applications. In drawing 1 a lighting device with a fixed outside dimension is required. The light source is also fixed. The drawing is a section through the LED element in the vertical plane. In the drawing five axial lighting devices are shown overlaid, one for prior art Sakai and one for each of the axial copending applications. Reflective surfaces contoured according to each of the copending applications and a reflective surface according to prior art Sakai are identified. A single typical side light ray is shown. Of the device is according to Sakai the light ray is reflected at point 1 and refracted at point 1'.If the device is according to application 08/631,821 (axial light concentrating) the light ray is reflected at point 2 and then refracted at point 2'. If the lighting device according to application 08/642,661 (converging reflector axial) the light ray is reflected at point 3 and refracted at point 3'. Finally if the lighting device is according to application 08/647,461 (angled converging reflector axial) the light ray is reflected at point 4 and refracted at point 4'. If the lighting device is according to 08/642,497 (bent refractor axial) the light ray is reflected at point 5 and refracted at point 5'. It can be seen that each of the light ray paths involve different angles of reflection, different angles of refraction and different lengths of light path to pass through the device. Each of those differences

represent different loss profiles which contribute to the overall loss profile and efficiency of the complete device. The designs are functionally substantially different. The actual efficiency of each of these lighting devices cannot be determined without a complex calculation of the efficiency for the light as it is reflected, refracted, transmitted, etc. The efficiency relating to the refraction and reflection depends upon the angles of reflection and refraction. This makes the calculation complex.

It is noteworthy to realize that the contour of the optics shown for Sakai would change greatly if a second section were taken through a second vertical plane diverging at an acute angle (such as 30 degrees) from the one used to create drawing 1. This is similarly true of applicant's four copending axial applications. Therefore, in this regard alone, Sakai is similar to the four copending axial applications when intersected with a diverging plane. Conversely, the contour of the optics would usually stay the same for each of applicant's copending planer applications. This results in a substantial difference in efficiencies between the axial design of Sakai and any of the current copending planer applications of Table I.

It is further noteworthy to realize that Drawing I is identical for both the group of axial and the group of planer copending application. The construction of the planer group of copending applications listed in Table I is achieved by moving the contours shown in Drawing 1 parallel to the reference plane. The construction of the axial group of copending applications listed in Table II is achieved by rotating the contours shown in Drawing I about the reference axis. The functional difference between the two types of construction becomes obvious if emerging light rays with azimuthal divergence are considered. For these light rays, the planer group of optical design creates far less bending and has generally higher efficiency. The planer group permits the light rays to remain diverging about a reference axis while reflecting them to become converging about the reference plane. The axial group bends all the light rays to converge about the

reference axis.